Forage Values on a Mountain Grassland-Aspen Range in Western Colorado

HAROLD A. PAULSEN, JR.

Principal Plant Ecologist,
Rocky Mountain Forest and Range Experiment Station
Fort Collins, Colorado

Highlight

The productivity, relative preference, and nutritive value of Idaho fescue makes it the most valuable forage species on summer cattle range on Black Mesa in western Colorado. Forbs that were abundant, high in nutritive value, and selected by cattle were aspen fleabane, aspen peavine, and agoseris in the mountain grassland type. Elk sedge was the major forage species in the aspen type.

West of the Continental Divide in the southern Rocky Mountains, open parks within the spruce-fir forests are occupied by a diverse herbaceous vegetation (Fig. 1). Intermingled are sites dominated by aspen (Populus tremuloides Michx.) that support a luxuriant understory of grasses and forbs. Thurber fescue (Festuca thurberi Vasey), a large bunchgrass, often characterizes the general aspect of the parks as well as the aspen understory. Hence, the grass-forb openings frequently are categorically referred to as Thurber fescue grasslands. Langehein (1962) described the "Festuca thurberi grasslands" of the Crested Butte area in western Colorado as a community with a wide elevational range that is found on deep soils and xeric exposures. Thurber fescue has been reported at elevations of 8,000 to 12,000 ft from southern Wyoming, Colorado, northern New Mexico (U.S. Forest Service, 1937), and westward in the Abajo Mountains of Utah and the Graham Mountains of Arizona (Kearney and Peebles, 1942).

In many respects these grasslands are similar to other high-elevation grasslands of the mountainous West. For example, in the Big Horn Mountains in Wyoming, grassland openings are dominated by Idaho fescue (Festuca idahoensis Elmer) (Hurd, 1961), which is an important species in western Colorado. In eastern Oregon and Washington, green fescue (Festuca viridula Vasey), also a bunchgrass, is encountered with Letterman and subalpine needlegrass (Stipa lettermanii Vasey and S. columbiana Macoun) and mountain brome (Bromus carinatus Hook. and Arn.) (Pickford and Reid, 1942), all of which commonly occur in western Colorado.

Many cattle graze the mountain grassland and aspen types of western Colorado. Cool climate, comparatively gentle topography, and nutritious forage make them highly prized for summer grazing. As an aid to management, information is presented here on the quantity, relative preference, and nutritive value of the important forage species.

In addition to their grazing value, the types provide ample watershed protection when not abused (Turner and Dortignac, 1954). As a consequence of past improper use, however, Thurber fescue has been replaced by less desirable species in many cases (Costello, 1954). Range improvement on mountain grassland sites may require a number of years (Strickler, 1961).

Study Area and Methods

Black Mesa is a segment of the Colorado Plateau at the western extremity of the Elk Mountains, approximately 100 miles southeast of Grand Junction, Colorado. Herbaceous vegetation is often dominated by Thurber fescue, but some sites are typified by nearly pure stands of hairy goldaster (Chrysopsis villosa (Pursh) Nutt. ex DC), a species of little forage value. Numerous other plant communities may be distinguished between these two extremes.

Elevations on Black Mesa range from 9,000 to 10,500 ft. The mesa is capped by a layer of volcanic material, principally Piedra rhyolite and Huerta andesite. The surface is dissected by intermittent streams which drop steeply from the rim to the major drainages which bound the mesa: Crystal Creek on the northwest, Curcanti Creek on the southeast, and the Gunnison River on the southwest. The loamy soils are generally fertile and productive, and range in thickness from a few inches to 3 ft or more. They grade into a tighter subsoil and unconsolidated rock. The solum may be more than 8 ft thick. Surface soils are relatively high in infiltration, water-holding capacities, and resistance to erosion.

Precipitation on the mesa is heaviest in late winter or spring; snow contributes approximately 4% of the total. Rainfall is least in June, and August is the wettest summer month. Although rainfall intensity may be high during thunderstorms, little moisture is lost through surface runoff.

Yearly records of herbage production from 1956 to 1965 have been obtained from permanent sampling points within two range units grazed by cattle. The units are 132 and 394 acres in size. Grassland and aspen comprise 80 and 98% of the two units, and spruce-fir forest the remainder. Grassland occupies 57% of the first unit and 46% of the second.

Thirty samples in the grassland and 10 in the aspen were established according to a stratified random sampling procedure. Preliminary tests had shown this to be adequate to sample total grass production on an air dry basis within
15\% of the mean with a probability of 95\%. At each sampling location, three systematically spaced 2.5-ft\(^2\) plots were marked along a 50-ft transect.

Production of individual species on each plot was estimated between mid-July and early August by the weight-estimate method (Pechanec and Pickford, 1937a). Double sampling was employed to provide a basis for adjusting the estimated values and for converting herbage production to an air dry basis. Separate ratios were determined for adjustments of the major species; average ratios computed from these were applied to the minor species.

Utilization was estimated on the permanent plots by the ocular estimate by plot method (Pechanec and Pickford, 1937b). Estimates on the grasses were made annually in late September or early October at the end of the grazing season. Intra-seasonal utilization estimates were made on all species between 1961 and 1963.

Samples of the major forage species were clipped periodically through the grazing seasons in 1962 and 1963. Dried and ground samples were analyzed by standard proximate analysis procedures for crude protein, calcium, and phosphorus (Association of Official Agricultural Chemists, 1960).

**Results and Discussion**

*Environmental Relations.*—Precipitation averaged 6.68 inches from June through September, and 28.83 inches between October 1 and September 30 for the study period. Because of inaccessibility of the area during most of the rest of the year, only total precipitation was recorded for the period October through May.

Following snowmelt the soil on Black Mesa is saturated. Soil moisture rapidly declined in June (Fig. 2) and below 1 ft there was little recovery during the summer despite increased precipitation in July. In the surface foot of soil, moisture fluctuated in response to the current precipitation.

From June through August, minimum temperatures averaged above freezing. Temperatures occasionally fell well below average for one to several days and noticeably curtailed growth even in these months.

*Herbage Growth.*—Very soon after snowmelt and usually in June, rapid herbage growth began. Herbage production reached its maximum by late July approximately 6 to 8 weeks after snowmelt. Unusually heavy snow cover or cool weather sometimes delayed peak production until August.

By mid-July most herbaceous species were flowering. Seeds ripened and were disseminated during late August and September. Limited vegetative growth was frequently observed until October, especially on the grasses. Forbs had largely disappeared from the standing herbaceous cover by this time.

Grasses averaged 53\% moisture when sampled for production; the several species ranged from 44 to 65\%. The forbs varied from 60 to 78\% moisture; individual species contained as high as 85\%. Parry rabbitbrush (*Chrysothamnus parryi* (A. Gray) Greene), the most abundant shrub in the grassland, averaged 67\% moisture. Turner\(^4\) has shown a significant relationship in moisture content among the major species on Black Mesa.

\(^4\)Turner, George T. Plant moisture relations as a basis for determining moisture content of rangeland herbage. Unpubl. data, Rocky Mountain Forest and Range Experiment Station, U. S. Forest Service, Fort Collins, Colorado.
Table 1. Herbage production (lb/acre, air dry) on mountain grassland and aspen ranges from 1955 to 1965, Black Mesa Experimental Forest and Range, Colorado.

<table>
<thead>
<tr>
<th>Year</th>
<th>Thruber fescue grassland range</th>
<th>Aspen range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grasses¹</td>
<td>Forbs</td>
</tr>
<tr>
<td>1955</td>
<td>920</td>
<td>520</td>
</tr>
<tr>
<td>1956</td>
<td>512</td>
<td>527</td>
</tr>
<tr>
<td>1965</td>
<td>484</td>
<td>677</td>
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<td>1965</td>
<td>828</td>
<td>701</td>
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<td>1960</td>
<td>751</td>
<td>814</td>
</tr>
<tr>
<td>1963</td>
<td>673</td>
<td>683</td>
</tr>
<tr>
<td>1964</td>
<td>510</td>
<td>546</td>
</tr>
<tr>
<td>1965</td>
<td>846</td>
<td>793</td>
</tr>
<tr>
<td>Avg</td>
<td>637</td>
<td>740</td>
</tr>
</tbody>
</table>

¹Includes sedges.

Total Production.—Herbage expressed as air dry pounds per acre averaged 1,456 lb on the grassland sites (Table 1). At the peak of production the grassland sites have a conspicuous forb aspect. Grass and grass-like species contributed 44% of the total herbage, forbs 51%, and shrubs 5%.

Herbage production is relatively more stable than on many ranges at lower elevations, which are often subject to more variable precipitation. For example, in 7 out of 11 years, total production was within 15% of the mean. Variations must be recognized in the management of these ranges, however; production ranged from 23% above average to 27% below during the study period. In successive years production has increased more than 700 lb/acre, but decreases between two successive years have been less pronounced.

Under the aspen canopy, herbaceous production averaged only about half as much as on the grassland sites. It was within 15% of the average in only 4 of 11 years. Forbs averaged 61% of the total production, and most of the remainder of the herbage was grasses and grass-like species.

Production of Species.—Idaho fescue was the primary forage producer on the grassland portions of the two range units. This species produced almost twice as much as Thurber fescue and Letterman needlegrass, each of which contributed about 8% of the total herbage. Other grasses that furnished between 3 and 4% of the herbage included slender wheatgrass (Agropyron trachycaulum (Link) Malte), and the bromegrasses (Bromus carinatus and B. anomalus Rupr.). Nine other grasses furnished the remainder. Parry rabbitbrush furnished 5.4% of the herbage. Fremont geranium (Geranium fremontii Torr.) was second to Idaho fescue in production of herbage. During the study period, nearly 14% of the herbage was composed of this one species, which has little, if any, forage value. The second highest forb contributor was hairy goldaster, which yielded slightly less than half the amount furnished by geranium. Three forb species—aspen fleabane (Erigeron macranthus Nutt.), aspen pea-vine (Lathyrus leucanthus Rydb.), and agoseris (Agoseris spp.)—together produced an average of 190 lb/acre, while 35 other species furnished 258 lb/acre. Of these only beauty cinquefoil (Potentilla pulcherrima Lehmk.) was consistent and appreciable; it contributed 3.4% to the total production.

Important species in the aspen type differ from those in the grassland, as shown below ranked according to percent composition.

Grass, grass-like 37.8
Bromegrass 3.2
Thurber fescue 3.2
Slender wheatgrass 1.6
Others 2.1
Shrubs 1.3
Forbs 60.9
Loveroot (Ligusticum porteri Coult. & Rose) 10.9
Aspen peavine 8.0
Meadow rue (Thalictrum dasycarpum Fisch. & Lall.) 5.9
Strawberry (Fragaria glauca (S. Wats.) Rydb.) 4.6
Osmorhiza (Osmorhiza obtusa (Coult. & Rose)
Fernald)— 3.0
Geranium 3.0
Bedstraw (Galium boreale L.) 2.6
Others 22.9

Fifteen species are grasses or grass-like, 26 are forbs, and 2 are shrubs. Elk sedge furnished the most forage in the aspen. As in the grassland, slender wheatgrass, bromegrass, and Thurber fescue were persistent contributors. Only loveroot of the forbs produced more than 80 lb/acre; 19 others provided from 0.1 to 2.9%. Often a species may have been especially abundant at a certain location, but lacked constancy in the understory.

From the annual appraisal of herbage production, stocking records, and utilization estimates of Idaho fescue, which averaged 38%, the grassland grazing capacity was computed to be between 1.4 and 1.7 animal unit months/acre.⁵ The coefficient of multiple determination of the relationship was 0.80. The projection is based upon the method suggested by Reid et al. (1963).

The two units are relatively small, fenced areas, all parts of which are readily accessible and rather uniformly grazed. Consequently, one should be wary of extrapolating these data to other areas of Thurber fescue grassland without adequate testing to assess the relationship of utilization, production, and stocking. They are of interest, however, in that they indicate a rather high grazing capacity for Thurber fescue grasslands under intensive management.

⁵An animal unit in this study was a 500- to 700-lb steer or heifer.
Table 2. Production, cattle preference, and relative forage value for forage species on mountain grassland ranges, Black Mesa Experimental Forest and Range, Colorado.

<table>
<thead>
<tr>
<th>Species</th>
<th>Production (lb/acre)</th>
<th>Percent utilization by number of days grazed</th>
<th>Forage value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>18 36 56 78</td>
<td></td>
</tr>
<tr>
<td>Grasses and grass-like</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Idaho fescue</td>
<td>222</td>
<td>5 8 15 38</td>
<td>1.00</td>
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<tr>
<td>Letteman needlegrass</td>
<td>126</td>
<td>3 4 8 32</td>
<td>.47</td>
</tr>
<tr>
<td>Thrumer fescue</td>
<td>119</td>
<td>4 7 16 48</td>
<td>.50</td>
</tr>
<tr>
<td>Bromegrass</td>
<td>51</td>
<td>6 9 14 38</td>
<td>.24</td>
</tr>
<tr>
<td>Slender wheatgrass</td>
<td>79</td>
<td>7 12 17 56</td>
<td>.22</td>
</tr>
<tr>
<td>Kentucky bluegrass</td>
<td>7</td>
<td>13 10 31 46</td>
<td>.04</td>
</tr>
<tr>
<td>Others</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forbs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspen fleabane</td>
<td>90</td>
<td>3 12 25</td>
<td>.26</td>
</tr>
<tr>
<td>Aspen penniset</td>
<td>65</td>
<td>3 6 10</td>
<td>.07</td>
</tr>
<tr>
<td>Agoseris</td>
<td>33</td>
<td>11 13 17</td>
<td>.07</td>
</tr>
<tr>
<td>False sunflower</td>
<td>9</td>
<td>9 44</td>
<td>.05</td>
</tr>
<tr>
<td>Goldenrod</td>
<td>11</td>
<td>1 18</td>
<td>.02</td>
</tr>
<tr>
<td>Dandelion</td>
<td>16</td>
<td>8 8 10</td>
<td>.02</td>
</tr>
<tr>
<td>Shooting valerian (Valeriana acutiloba (Ryd.) F. G. Meyer)</td>
<td>11</td>
<td>1 6 14</td>
<td>.02</td>
</tr>
<tr>
<td>Others</td>
<td>500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Ranking based upon the product of final utilization and production divided by the product obtained for Idaho fescue. Species listed were present on at least 5% of the plots.

Cattle Preference.6—For 3 years, estimates of percent utilization of species on the grassland and aspen sites were obtained 17 to 21 days, 34 to 40 days, 54 to 61 days, and 75 to 82 days after grazing began. Grasses and grass-like species only were estimated in the final period because of the disappearance of the forbs late in the season. The relative ranking of the primary forage species based upon percent use and production of herbage is shown in Tables 2 and 3.

Idaho fescue must be recognized as the primary forage species in the grassland on Black Mesa. This species was also one of the most preferred species wherever it occurred on the Big Horn Mountains (Hurd and Pond, 1958). Not only does it rank high in preference, but in combination with production it rated more than twice as high as the next closest species, Letteman needlegrass. Thrumer fescue, which is sometimes considered to be of doubtful forage value, does contribute substantially to the forage resource as indicated by its third place rating. Kentucky bluegrass (Poa pratensis L.) was more heavily grazed than other grasses present on at least 5% of the plots; due to its limited production, however, it ranked low in the relative forage value rating. Other species which were 20 to 25% utilized by the end of the grazing season included prairie junegrass (Koeleria cristata (L.) Pers.), sedge, and subalpine needlegrass.

Certain forbs contribute appreciably to the forage resource. The value of aspen fleabane, for instance, which furnished 90 lb/acre of herbage, is significant in the grazing resource. In addition, aspen peavine and agoseris furnish appreciable quantities of forage and are highly preferred by cattle. The most highly preferred species was false sunflower (Helianthella quinquervis (Hooker) A. Gray) which was utilized an average of 44% after 56 days of grazing. Other forbs utilized in excess of 10% included silverweed cinquefoil (Potentilla anserina L.), aster (Aster spp.), and bluebell (Campanula rotundifolia L.).

Certain species are grazed early but then receive little additional utilization the rest of the season. For example, dandelion (Taraxacum officinale Wiggars) was grazed an average of 8% after 18 days but only 10% after 56 days. In contrast, utilization of aspen fleabane increased steadily through the season.

The most striking changes in utilization of the grasses occur after the forbs die back with freezing weather. Up to 56 days, however, utilization of the forbs and grasses is very similar. Kentucky blue grass and false sunflower were grazed noticeably more than others of their class up to this time. Because of greater production, preferred grasses contribute appreciably more to the animal's diet than do the preferred forbs. Nevertheless, the palatable forbs are very important components of the forage resource, and must be recognized in management of these ranges.

Forage use was generally less in the aspen type than in the grassland. Elk sedge was not heavily...
grazed, but it rated 2.5 times higher than any other species. Kentucky bluegrass, subalpine needlegrass, and blue wildrye (Elymus glaucus Buckl.) were used in excess of 10% but produced relatively little forage in the aspen.

Forty-nine species of forbs were encountered in the aspen type, and 34 of these were noticeably utilized. Use was highest on false sunflower, which was grazed only 7% less than in the grassland; however, meadowtrue ranked highest in relative forage value of the forbs. Other forbs utilized at least 5% were:

Days after grazing began
21 38 (Continued)
Aspen fleabane
Dandelion
Agoseris
Grays peardinis (Pedicularis grayi A. Nels.)
Orange sneezeweed (Helennium hoopesii A. Gray)
Aspen fleabane
Solomonplume (Smilacina)

Forage Nutritive Value.—Chemical analyses of forage collected at specific phenological stages during 1962 and 1963 are reported in Table 4. Precipitation during rapid growth in June and July was similar in these years; 1.68 inches in 1962 and 1.52 inches in 1963. When first collected in July, the inflorescences of Idaho fescue were fully expanded but had not reached anthesis. Thurber fescue and Letterman needlegrass were similar to Idaho fescue, but slender wheatgrass and bromegrass were somewhat farther advanced. Elk sedge, on the other hand, had already flowered and was collected only in a vegetative stage.

The three forbs which furnish appreciable amounts of forage were collected regularly for analysis. Aspen peavine and agoseris were in bloom when first collected at the time grazing began. Aspen fleabane reached a comparable stage approximately 2 weeks later.

The three forbs were nutritionally superior to the grasses through the first half of the grazing period. Aspen peavine averaged highest in crude protein, and agoseris was highest in phosphorus and calcium.

It is interesting that the forbs, even after they were dry and decumbent, showed crude protein, phosphorus, and calcium levels still above the minimum nutrient requirements prescribed for maintaining normal growth of 600-lb steers or heifers (National Research Council, 1963). In contrast, by late August when the grass seeds were being disseminated, crude protein and phosphorus were below the prescribed minimum requirement in the three major forage grasses. By mid-September those elements were deficient in the herbage of all grasses.

Calcium was ample in each of the species throughout the entire grazing season. The calcium content of the three forbs averaged almost four times higher than the grasses, and tended to increase in the later developmental stages in contrast to the grasses.

Elk sedge samples from the aspen type were obtained at three periods during the 2 years. Since flowering had been completed, only the leaves were collected for analysis. The crude protein content of elk sedge through late August was slightly higher than that of Idaho and Thurber fescues. By mid-September the protein content of the three species was similar. Similarly, phosphorus content of elk sedge at this late date was about minimal for the nutritional requirements of the animals, but calcium was adequate.

Most grass and sedge herbage on Black Mesa appears to be nutritionally deficient after late August. Animal weights early in the study showed an average of 1.5 lb/head/day gain from approximately September 1 until October 1. The gain from mid-July until September 1 averaged 2.4 lb/head/day, or about 62% more than late in the season. When grazing is terminated it is doubtful
whether any weight gains are being made. Studies in other areas have shown significant losses in animal weights late in the season (Klipple and Costello, 1960; Johnson, 1953).

Summary

Mountain grassland and associated aspen ranges furnish forage for a large segment of the livestock industry of western Colorado. To characterize these ranges, data are presented which illustrate herbage production, cattle preference, and nutritional value of the major forage species.

The study site is on Black Mesa about 30 miles west of Gunnison, Colorado, at an elevation of approximately 9,500 ft. Hereford steers or heifers have grazed the experimental area from mid-July until approximately October 1 since 1954.

Herbage production on the grassland averaged about 1,500 lb/acre air dry, and reached its peak between mid-July and early August, depending upon the weather. Composition of the herbage averaged 44% grasses and grass-like species, 31% forbs, and 5% shrubs.

The associated aspen ranges, which are contiguous with the grasslands, yield approximately half as much herbage. Forbs comprise a higher percentage of the herbage than in the grassland. Towards the end of August, the forbs on both types of range become dry and thereafter contribute very little to the animals' diet.

Idaho fescue is the primary herbage producer in the grassland, while elk sedge is the major producer in the aspen type. Other grasses which furnish appreciable amounts of grassland herbage include Thurber fescue and Letterman needlegrass. Fremont geranium contributes more herbage than any other forb in the grassland, but production in the aspen is furnished by a variety of forbs.

On the grassland ranges, cattle preference, as determined by periodic estimates of utilization, was highest for Kentucky bluegrass and false sunflower. The latter species is also most preferred on the aspen ranges.

The product of herbage production and utilization provided an index of forage value. On the grassland, Idaho fescue ranked more than twice as high as any other species, followed by Letterman needlegrass and Thurber fescue. Aspen fleabane, aspen peavine, and agoseris are the major forage species of forbs. Elk sedge and meadowrue ranked highest in forage value in the aspen type.

Chemical analyses indicated the forage grasses may be deficient in crude protein and phosphorus after seed ripening. Forbs, on the other hand, maintain an adequate level until they dry and are no longer grazed. Calcium levels of forbs and grasses were adequate throughout the grazing season.

Literature Cited


